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ABSTRACT

The creation of "Higher Education Corporations" in the United Kingdom is discussed within the context of what one Polytechnic has done in creating a Decision Support System to address the problems found in resource management, cost control, and competitive bidding. A summarization is included of the actions taken by the Polytechnic in its progress towards resource conscious course design and delivery. A particular focus is the need to estimate, monitor, and control marginal costs in the face of the requirement to bid competitively for part of the target enrollment. Resource allocation and cost control methodology are examined along with the development and application of management models in making assessments and other measurements for decision making, including decisions involved in competitive tendering. Contains four references. (GLR)

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DECISION SUPPORT SYSTEMS FOR FINANCIAL PLANNING AND CONTROL IN A UK POLYTECHNIC

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This paper was presented at the Thirtieth Annual Forum of the Association for Institutional Research held at The Galt House, Louisville, Kentucky, May 13-16, 1990. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum Papers.

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ABSTRACT

Higher Education in the UK has changed dramatically with the creation of "Higher Education Corporations", funded by a new body charged with applying commercial controls on costs and value for money, and creating a competitive market for the supply of HE. The paper describes the response of a major UK Polytechnic in developing Decision Support systems for Resource management and cost control. A particular focus is on the need to estimate, monitor and control marginal costs in the face of the requirement to bid competitively for part of the target enrolment. The intended audience is both educational managers and providers of DSS.

CONTEXT

This paper deals with the development of Decision Support Systems (DSS) for a UK polytechnic in the current competitive tendering climate. A major change occurred in April, 1989, with the implementation of the Educational Reform Act, which made polytechnics and some other major colleges independent accountable bodies - "Higher Education Corporations". A new funding body - The Polytechnics and Colleges Funding Council (PCFC), came into being, charged with the task of distributing funds within the sector, implementing stringent commercial controls over costs and value for money and applying a market economy philosophy to the funding of HE. Institutions are now participating in a competitive tendering process for a proportion of their funding. The provision of the Sector is divided into nine generic "programme areas"

1. Engineering
2. Built Environment
3. Science
4. Information Technology
5. Business
6. Health and Social Services
7. Humanities
8. Art and Design
9. Teacher Training

"Core" funding is provided for each of these areas. For the financial year 1990/91 this amounts to 95% of the PCFC's funds, and is intended to cover provision for 95% of the students who were funded in the previous year. The remaining 5% of funds was subject to a competitive bidding process for the

funding of enrolments beyond core levels. All funding will be provided subject to a quasi-commercial contract, including provision for claw-back if enrolment targets are not met.

The Polytechnic has responded by re-structuring into cost centres; 10 academic Schools and 9 non-academic centres, with cash limited devolved budgets. The functions of the Polytechnic's Directorate and the Heads of Schools have correspondingly changed significantly to a very largely managerial role.

All of this has led to both an increase and a change in information requirements, and beyond this to a need for Decision Support Systems by the Polytechnic's senior management; in particular in relation to costs and incomes and resource utilisation. This paper describes the approaches adopted to meet these needs and the continuing process of refining and reviewing the methodologies that have been adopted.

LITERATURE REVIEW

The (very largely American) literature on costing in Higher Education is extensive. Simpson (1984) provides a useful review of the problems of developing cost models, and places particular emphasis on the subjective elements inevitably involved and the need to relate costing methodology to the uses to which it is to be put. In the Polytechnic's case this is especially relevant to the need to reflect the recent changes in the funding approach of the PCFC.

Hoenack, Weiler, Goodman and Pierro (1986) provides some interesting theoretical structures for marginal costing and demonstrates the desirability

of considering economic cost models as well as accounting cost. The economic cost of an activity may well be different for academic staff, institutional management and a funding body; this has behaviourial implications for the system which should be taken into account. This is particularly so when enrolments are changing, and McLaughlin, Montgomery, Smith, Mahan and Broomall (1980) give a statistical analysis of a large number of US HE Institutions which suggests that size alone has very little direct influence on costs, but rather it is complexity which has a much more important influence. The suggestion is, therefore, that if the Polytechnic is to expand enrolments at a low price, it should take into account the fact that an increase in complexity may naturally result, which would increase marginal costs to an unacceptable level. This has led to an increasing integration of course cost and resource constraints with considerations of academic content and course delivery methods in course design and review

The literature on marginal costing is heavily oriented to analysis at the institutional level. Allen and Brinkman (1983) give an excellent review of this area, with an extensive bibliography. They include a clear discussion of the relationship between the Economic Theory of cost and the application of concepts such as "marginal cost" to Higher Education, demonstrating the need to bear in mind the differences between Education and the Economic paradigm. In the discussion that follows, it should be remembered that the use of such Economic terms is at best an approximation and, for instance, ignores the cost minimisation assumptions of Economic Theory, and the requirement for a formal production function. Interestingly, the ratios of marginal cost to average cost found in the studies reviewed nearly all fell in a range from 55% to 70% for undergraduate programmes, which is consistent

with the course level analyses quoted later in this paper, although these relate only to staffing costs.

BUDGETARY ALLOCATION AND PERFORMANCE EVALUATION

Having adopted a devolved financial management system, the distribution of the Institution's course derived income to the constituent centres presents a modelling challenge in its own right. Figures 1 and 2 represent diagrammatically the system flow of funds and information during the Budget Allocation process and School Performance/Cost Evaluation respectively. Three key models are used in these processes.

The Student Allocation Model firstly assigns proportionally students in each programme area to each School, in a manner consistent with the School contribution to the teaching and administrative requirements of the courses. Hence, from the funding level provided in each programme area, the model supplies a theoretical income at School level for Budgeting Allocation Use and Performance Evaluation purposes. Although declared "theoretical", the figure is considered to be, in practice, the closest obtainable to a true School revenue figure.

However, recognising that the cost of educational provision is not precisely related to income derived from that provision in the short term, a hybrid approach, based upon existing fixed costs and variable costs (student number related) has been derived to represent necessary unavoidable expenditure to support a particular School activity. The fixed cost element is, almost by definition, dominated by staffing costs and hence can only be adjusted opportunely. The variable cost element, however, attempts to model the

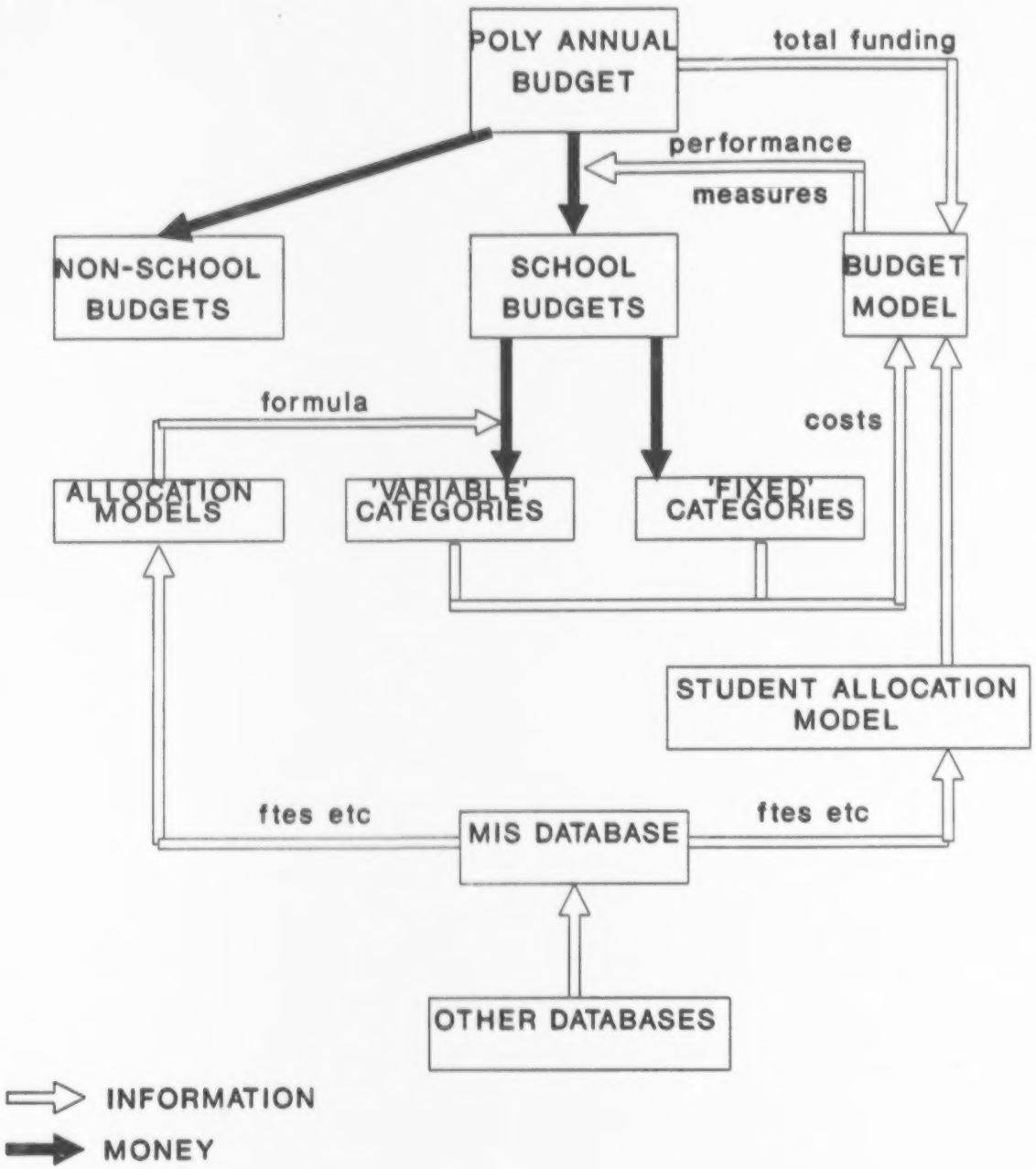

FIG 1. Budget Allocation and Control System

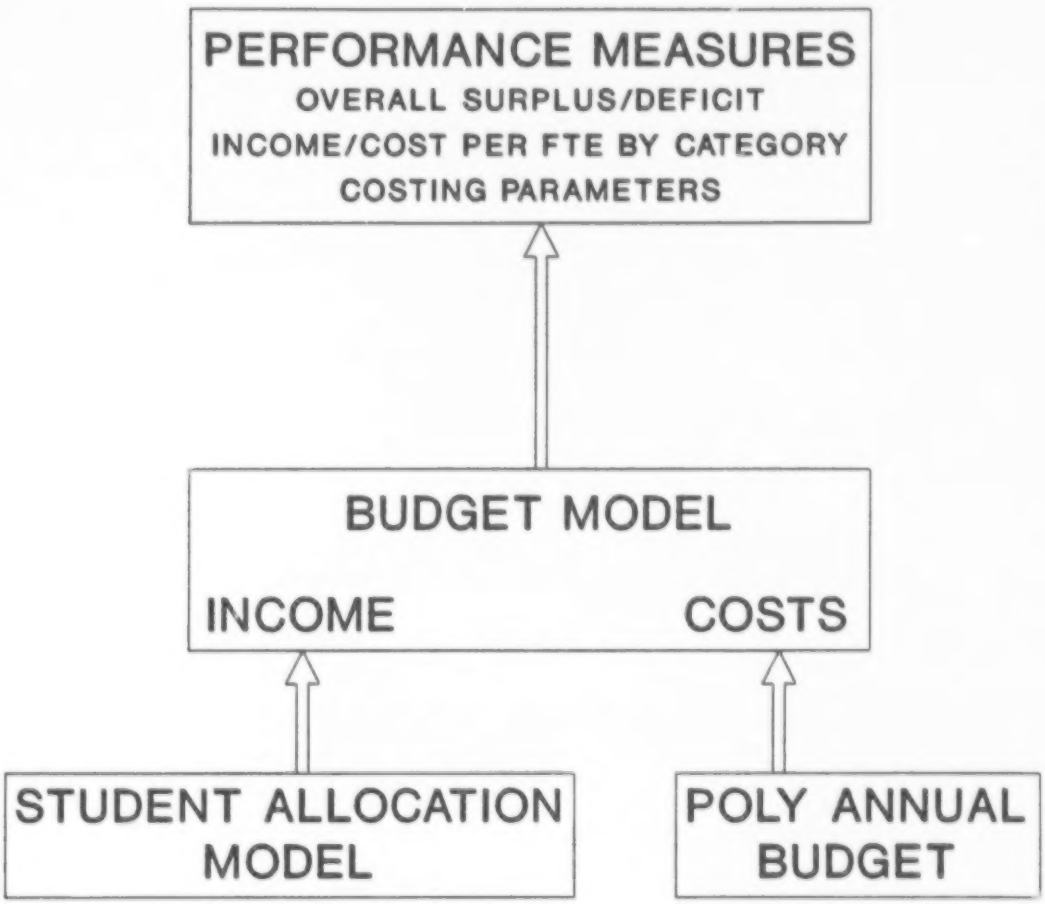

FIG 2. School Performance/Cost Evaluation

Institution's non-labour direct costs of student learning via a range of allocation models. Together, these elements provide a "need" budget for the constituent Schools.

The merging of these models and subsequent performance measurement of the Schools is provided within the Polytechnic Source and Applications Flow Model, which produces absolute and relative performance measures for senior management use in decision support. Essentially, the output of such a model provides the equivalent of a Source and Application of Funds statement for the course provision activities of the Institution. It has extensive potential applications in Performance Appraisal Systems, and each School is now subject to an annual audit as part of this.

COURSE ASSESSMENT

An analysis of the component elements of a course (see Figure 3) provides information on the distribution of staff and student time, average group sizes and other statistical information. Resource implications, especially for staffing input and room usage, are also derived. Linking in the school costing parameters derived from the budget model provides a full cost costing model of the course. The effects of changes in course design or cohort size are readily assessed, providing an invaluable aid to course design and review.

The blending of such resource analysis into the decision process, during concept analysis and academic course design and review, represents but one use of such a model. In a climate of competitive tendering, it provides an invaluable decision support tool for senior management in bid estimation.

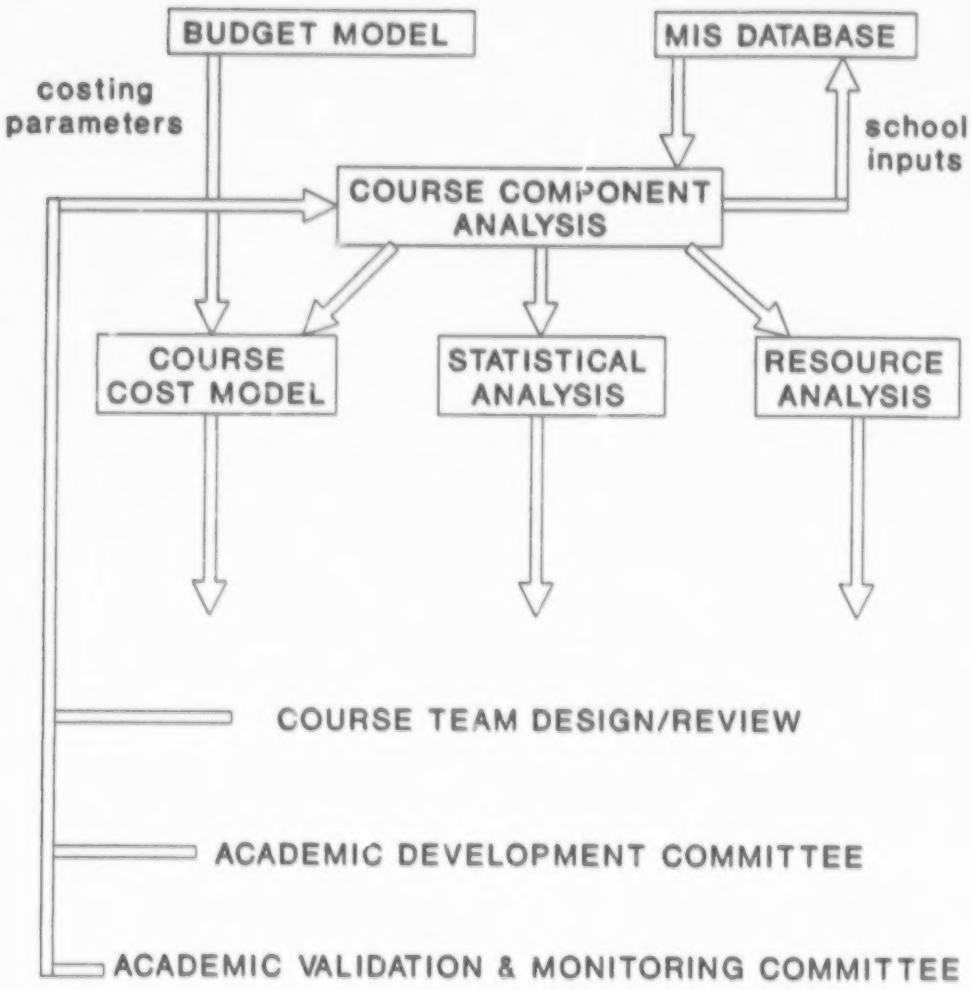

FIG 3. Course Review and Monitoring System

MARGINAL COSTS

The cost/resource model of a course can also be used to estimate the marginal costs of varying enrolment levels for a given course design. Figures 4 and 5 illustrate this type of analysis for the staffing costs of two example courses in different programme areas. In each case, the top graph shows the total staff cost function which is the combination of a set of linear and step function curves for each component of the course. Linear cost curves result from activities such as individual project supervision, step functions result from the need to split students into groups determined either by room capacity (e.g. computer laboratories) or academic considerations such as the maximum size of a seminar/tutorial group. As can be seen, the programme 4 (Information Technology area) cost curve is dominated by the step functions related to capacities of specialist computing laboratories. The programme 5 (Business area) course is smoother, but with discernable steps relating to seminar group constraints.

The bottom graph in each case shows the staffing cost represented as an average cost per student curve. In both cases, this is approximated quite well (R^2 =.88 and .94, respectively, for figures 4 and 5) by a model of the form:

$$C = an^{-b}$$

where C is the average staffing cost per student;

n is the number of students enroled;

a,b are parameters ($0 < b < 1$).

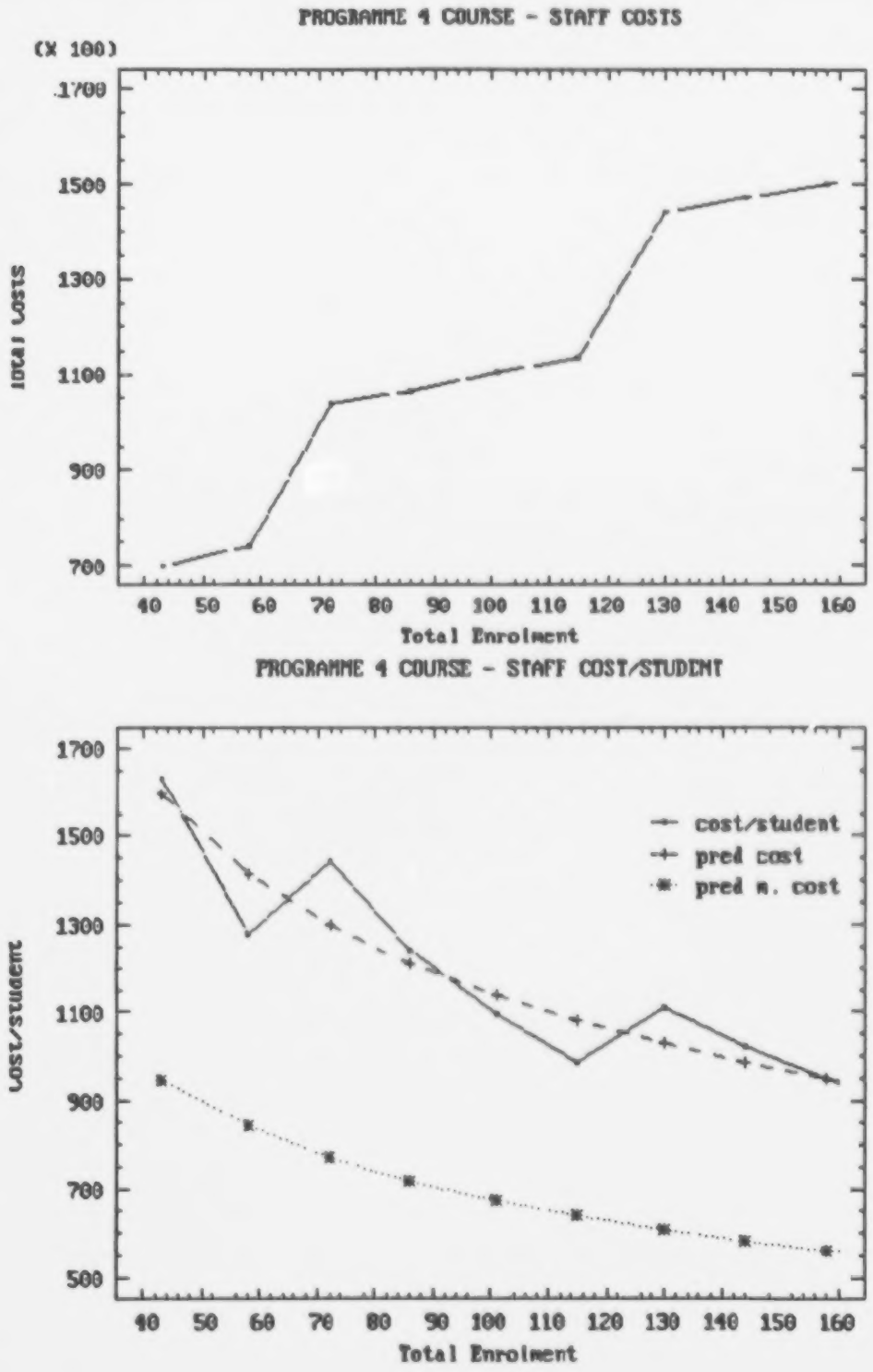

FIG 4. Staff costs for Programme 4 course; Total, Per Student and Marginal

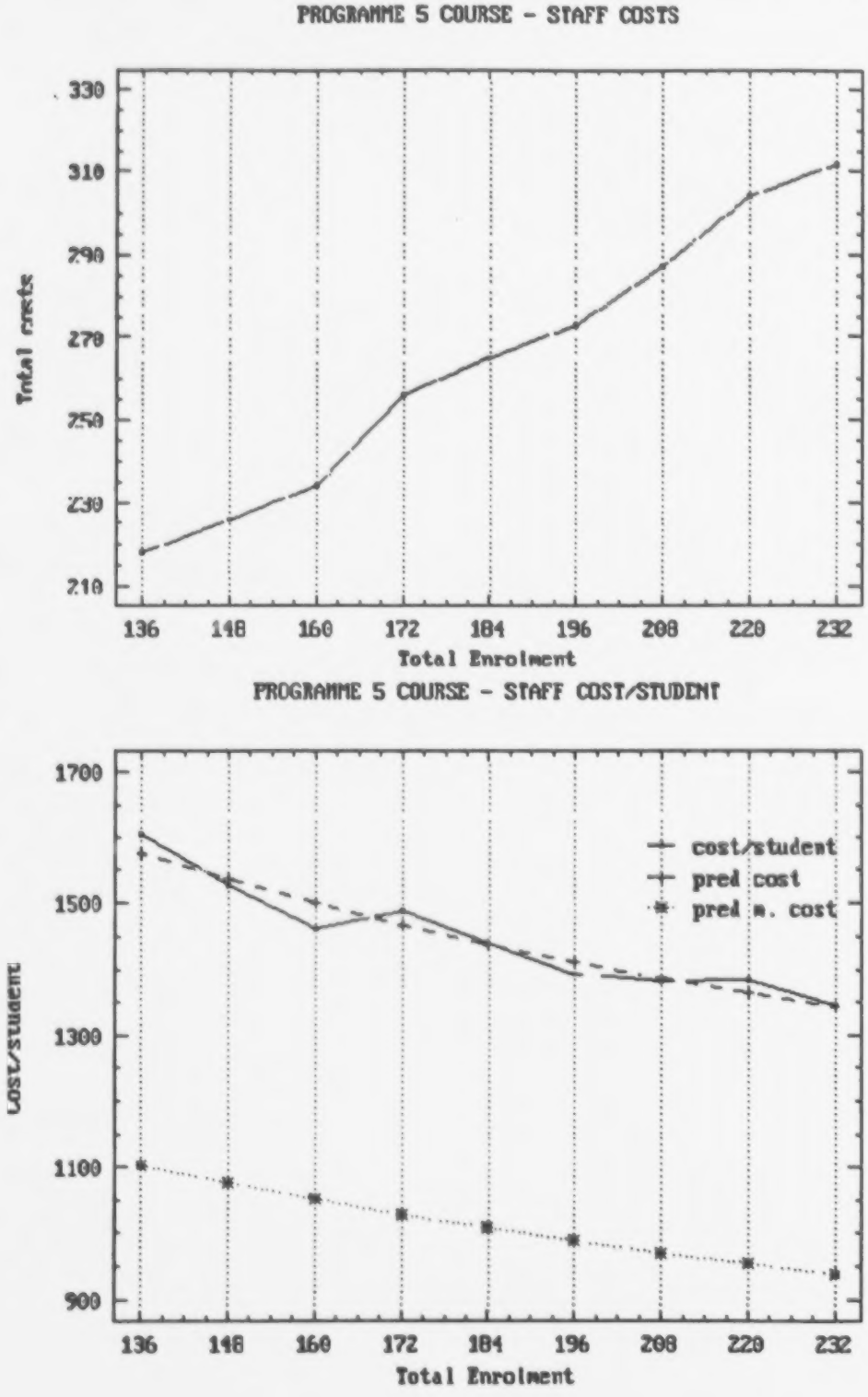

FIG 5. Staff costs for Programme 5 course; Total, Per Student and Marginal

Some simple calculus yields the marginal cost per student (M) for a given number of students enroled as:

$$M = a(1-b)n^{-b}$$

This curve is also shown plotted, and implies that the marginal staffing cost per student is a constant proportion, equal to (1-b), of the average staffing cost. For the programme 4 course this proportion is approximately 60%, while for the programme 5 course it is approximately 70%. An analysis of other variable costs, such as room costs, yielded similar results. The other costs of course provision, amounting to at least half of the total cost, are partly fixed and partly variable, but the effect of expanding enrolments on existing courses by feasible amounts will only have a small effect on average costs, regardless of their nature. For instance, if half of the costs of the programme 5 course were staffing costs and the other half was fixed, the effect of expanding enrolments by 10% from 200 to 220 would be a reduction in average cost of 5.9%. At the other extreme, if all other costs varied linearly with enrolments, the reduction in average costs would only be 1.4%, so it is unlikely that in fact the reduction would be more than about 3-4%,

This type of analysis gives some indication of the costs of expanding existing courses and the likely effects on average costs of doing so. Some indication is thereby gained of the scope for operating under a degrading unit of funding

COMPETITIVE TENDERING

This year, for the first time, Institutions have had to bid competitively in a "sealed envelope" process for funding to cover any students above the "core"

of 95% of last year's funded numbers. Bids were made by programme area, each of which has an advisory group which makes recommendations to the PCFC. Each group set a maximum and minimum price for bids in the area and a maximum growth rate on last years enrolment for any one institution. Maximum prices were set at around the median price for core funding in the programme area. The allocation of funding was then largely determined by a formula dependent on price. Quality of provision was only taken into account in so far as a small number of institutions were classified as being of high quality for course provision in the programme area and their prices were discounted, typically by 10%. The allocation formula used was:

$$g = G(b-P_{MIN})/(P_{MAX} - P_{MIN})$$

where g is the allocated percentage growth on last year's numbers;

G is the maximum allowed growth;

b is the bid price;

P_{MIN} is the minimum price;

P_{MAX} is the maximum price.

Figure 6 shows the application of this formula diagrammatically for an example programme area. The maximum allowable growth for this area is a little over 20%, and the price range is from 2000 to 4000. As can be seen, a bid of around 3600 would result in zero growth (the core of 95% plus an additional 5%), a bid of around 3200 resulting in a growth of 5%. Bearing in mind that the maximum price is set at an average level for the core funding, it can be seen that even to stand still implies a significant reduction in the unit of funding, with a further degradation resulting from any bid for growth. This is further exacerbated by the fact that the core funding has a built in

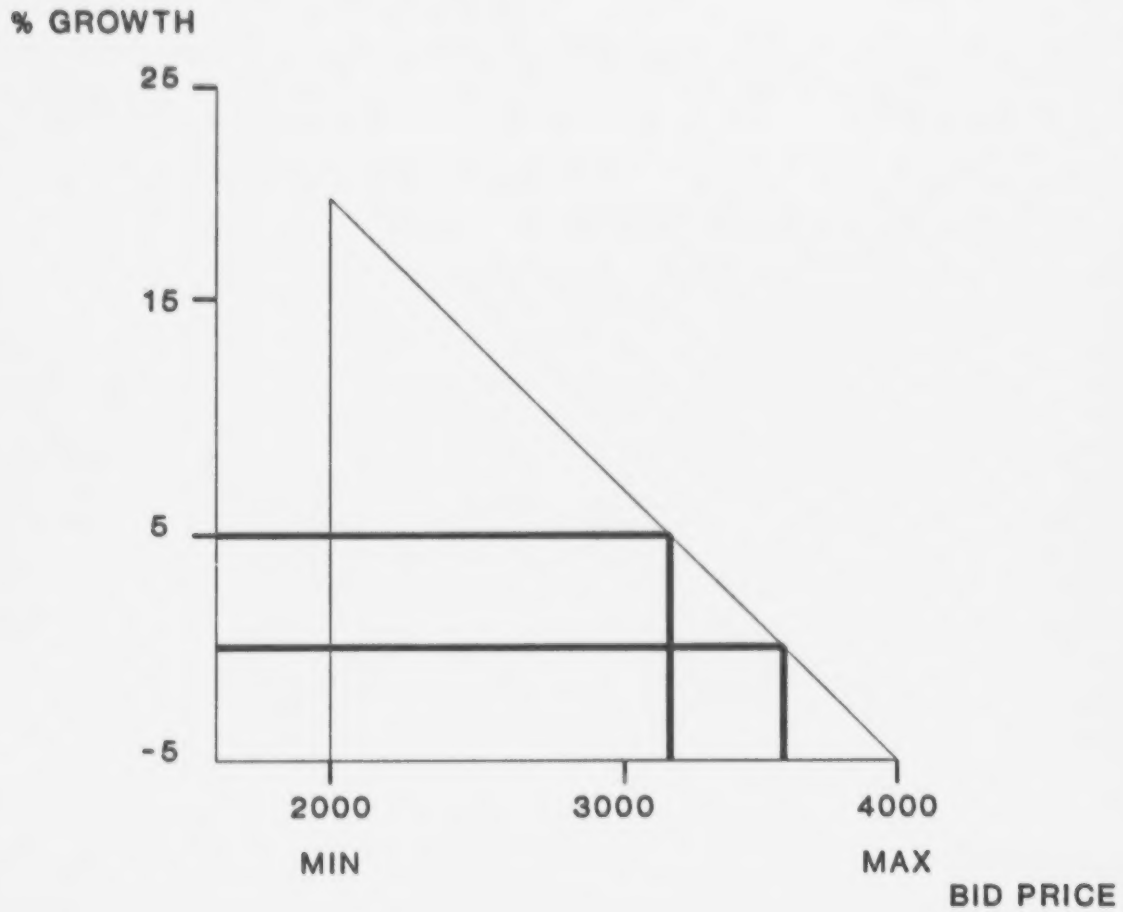

FIG 6. PCFC Bid Price v Growth for example Programme Area

inflation allowance which is significantly below the actual inflation in costs being experienced by the system.

Starting with the lowest bid, numbers were determined by the smaller of the bid number and the number given by the allocated growth rate. Multiplying this number by the bid price gave the funding for that institution. This process was continued for increasing prices until the funding allocation for the programme area was exhausted, or all the bids up to the maximum price had been dealt with.

This process naturally focuses attention upon the marginal cost of tuition. Overhead recovery will inevitably have a role to play in this bidding strategy, but it is the estimation of marginal revenue and costs for a change in funded student numbers that is the focal point for attention. As the previous section indicated, relying on a reduction in average costs resulting from feasible growth rates for existing courses is not likely to keep pace with the rate of degradation in the funding unit resulting from the new PCFC funding mechanisms. For a School operating in programme areas where the current average costs of instruction lie at around P_{MAX}, the situation is indeed grave. A shrinkage of funded student numbers, and hence revenue, is an inevitable consequence of unsuccessful tendering. Conversely "successful" tendering would involve acquiring revenue below the marginal cost of instruction with an increasing subsidy requirement. The situation is economically unsustainable.

courses are unlikely to reduce average costs sufficiently to match the rate at which the funding unit degrades as a result of the bidding process.

Specifying a resource envelope within which a course must be designed represents a major reversal in design where previously, desirable academic characteristics formed the only real basis of curriculum definition - resource matters being considered retrospectively, if at all.

A major design exercise is currently under way for one of the Schools which was already in a substantial deficit situation even before allowing for the effects of the bidding process. The starting point was to specify a staffing cost which could be sustained, given the level of other costs after they had been reduced by as much as was possible, and a feasible expansion of student numbers. The School has decided to provide the majority of it's courses via a flexible modular system, where students select 8 modules for study each year. Setting the target staffing cost as 1000 per student thus results in a target cost of 125 for each module. Staff designing the modules were given a handbook detailing the cost and resource implications of different delivery patterns, and instructed to try to hit the staff cost target set. The result was that most modules came in at significantly lower than the target set and in most cases it was decided to increase the staffing requirement! A standard module design was settled on to cover most cases, where there were no special

additional resource requirements (such as the use of special equipment or studio/laboratory facilities), consisting of a weekly allowance of lectures

A complete model of the course has been constructed relating the numbers taking each module, the design of the module and the resource and cost implications. This builds up to a macro level giving the final income/cost position of the School, including all it's other activities. Various simulations can be run with this model, examining the effects of any further changes in module design, and especially in considering different uptakes of the modules when students make their choices on enrolment. This will also help to determine which modules should run in a year and figure 7 illustrates the effects of different levels of uptake for a standard module, produced as an aid to this process. As can be seen it leads to a simple decision rule such as:

30+	run module
16-30	maybe run module
<16	do not run module

When all choices are modelled, final decisions can be taken on the indeterminate cases.

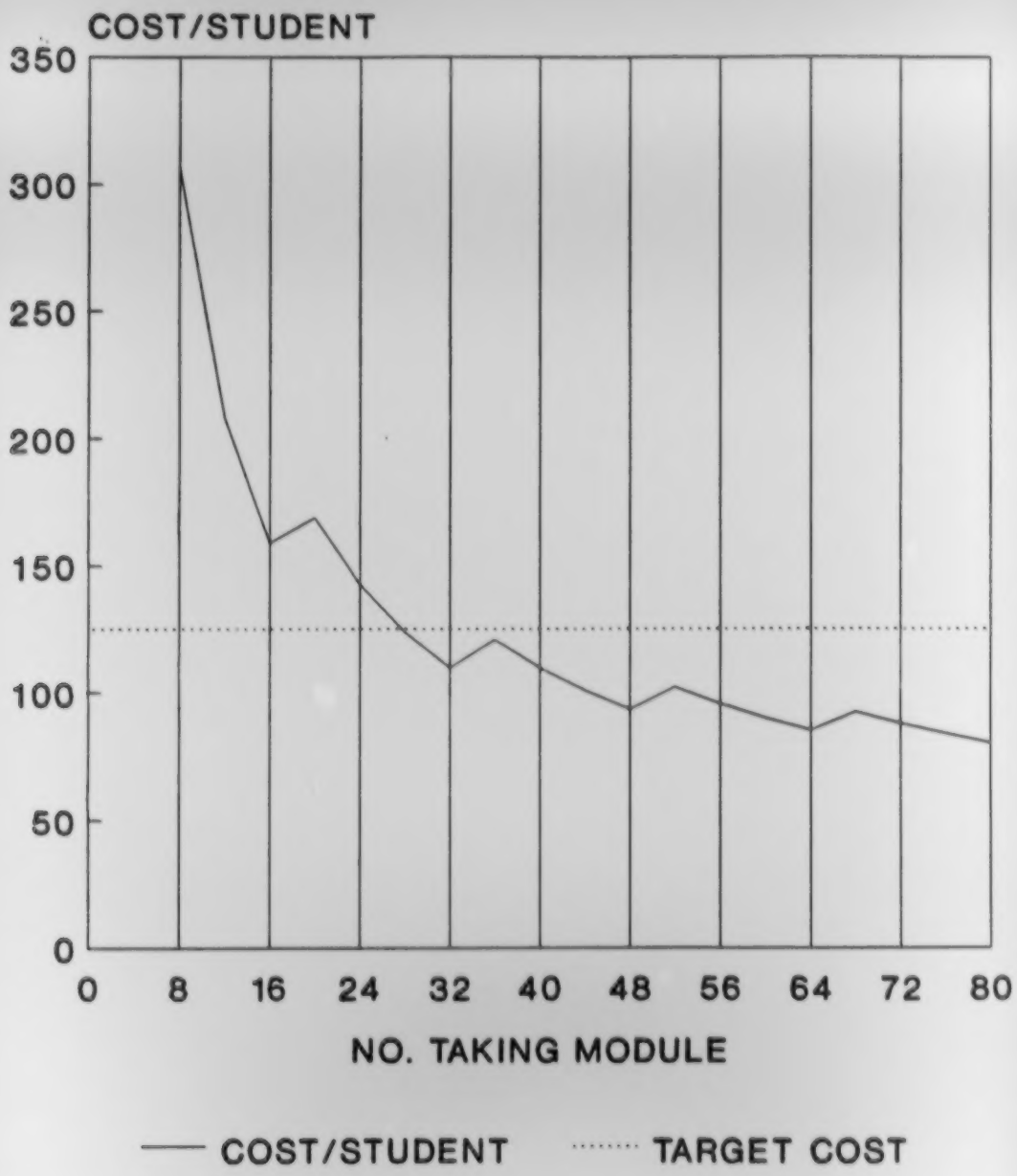

FIG 7. Staff Costs for Standard Module v Uptake

CONCLUSION

Within the context of UK Higher Education there is a dearth of published material which identifies the relationship between academic practice and resource consumption. This paper has attempted to summarise the actions taken within one of the largest UK polytechnics, in its progress towards resource conscious course design and delivery. The advent of competitive bidding, and its associated emphasis upon value for money in education, has increased the necessity for this focus.

The Polytechnic has well established procedures for the control of the academic quality of it's courses, and was one of the first institutions in the PCFC sector to be granted full accreditation status for the award of degrees. There is no intention of diluting this process, but resource constraints must now be considered as an integral part of course design. The historical dislocation between academic design and resource issues would never be tolerated in a productive industry; it is likely to be transformed into a unified academic/resource design process during the decade.

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